STATUTORY DECLARATION

I, Ho Jin PARK, a citizen of the Republic of Korea and a staff member of Y.H.KIM INTERNATIONAL PATENT & LAW OFFICE specializing in "APPARATUS AND METHOD OF PATTERNING AN ELECTRO-LUMINESCENT DISPLAY DEVICE", do hereby declare that:

(1) I am conversant with the English and Korean languages and a competent translator thereof.

(2) To the best of my knowledge and belief, the following is a true and correct translation of the Priority Document (No. 2000-21297) in the Korean language already filed with Korean Industrial Property Office on April 21, 2000.

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Ho Jin PARK

PATENT APPLICATION

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[ABSTRACTS]

[Abstract]

In a method and apparatus for patterning forming pixels into minute patterns in an electro-luminescent display device, a molding plate having convex and concave portions is attached to a roller and rotated. A polymer solution is applied to the molding plate via another roller. The polymer solution thus coated on the molding plate is printed on a substrate by rotation of the molding plate. Barrier ribs may be formed on the substrate to prevent spreading of the deposited polymer solution.

[Representative drawing]

FIG. 6a

[SPECIFICATION]

[Title of the invention]

APPARATUS AND METHOD OF PATTERNING AN ELECTRO-LUMINESCENT DISPLAY DEVICE

[Brief description of the drawings]

Fig. 1 is a schematic section view showing the structure of a conventional organic electro-luminescent display device.

Fig. 2 is a section view showing an apparatus of patterning an electro-luminescent display device according to an embodiment of the present invention.

Fig. 3 is a partial enlarged view of the portion indicated by "A" in Fig. 2.

Fig. 4 is a detailed perspective view of the molding plate shown in Fig. 2.

Fig. 5 is a partial enlarged view of the portion indicated by "B" in Fig. 4.

Figs. 6A to 6C are sectional views representing a process of forming pixel patterns of the electro-luminescent display device using the patterning apparatus shown in Fig. 2.

Figs. 7A to 7C are sectional views showing a membrane spread of the pixel pattern shown in Fig. 6C.

Fig. 8 is a plan view showing barrier ribs formed between pixel patterns in a method of patterning pixel patterns according to a second embodiment of the present invention.

Figs. 9A to 9D are sectional views representing a process of forming pixel patterns of an electro-luminescent display device on a substrate shown in Fig. 8 on which the barrier ribs are formed.

Fig. 10 is a plan view showing barrier ribs formed between pixel patterns in a method of patterning pixel patterns according to a third embodiment of the present invention.
Figs. 11A to 11D are sectional views representing a process of forming pixel patterns of an electro luminescent display device on the substrate shown in Fig. 10 on which the barrier ribs are formed.

Detailed descriptions of the reference number

2: glass substrate
4: molding roller
6: molding plate
8: polymer supplying roller
12: lands
14: grooves
16: EL polymer solution
18, 20a: pixel pattern or organic material layer
12a: hemispherical grooves
31: anode electrode
32: hole injecting layer
33: light-emitting layer
34: electron injecting layer
35: cathode electrode
40, 50: barrier ribs
42, 52: ITO pattern

[Detailed description of the invention]

[Object of the invention]

[Technical field including the invention and prior art therein]

This invention relates to a technique of fabricating a flat panel display device and more particularly to an apparatus

and method for patterning an electro-luminescent display device that is adaptive for forming pixels into minute patterns in the electro-luminescent display device.

Recently, there have been developed various flat panel display devices reduced in weight and bulk that is capable of eliminating disadvantages of a cathode ray tube (CRT). Such flat panel display devices include a liquid crystal display (LCD), a field emission display (FED), a plasma display panel (PDP) and an electro-luminescent (EL) display device, etc. Studies for heightening a display quality of the flat panel display device and for providing the flat panel display with a large-scale screen have been actively made. The PDP in such flat panel display devices has been highlighted as a display device having the most advantage of a light-weight, a thin thickness and a small bulk as well as a large-scale screen owing to its simple structure and manufacturing process, but has great drawbacks of a low emission efficiency, a low brightness and a high power consumption. An active matrix LCD applying thin film transistors (TFTs) for switching devices has a difficulty in providing a large-scale screen because it should exploit a semiconductor process, but has been largely used for a display device of a notebook computer to have an enlarged demand. However, the LCD has large drawbacks in that it has a difficulty in providing a large area and it has high power consumption due to a backlight unit. Also, the LCD has characteristics of a large light loss and a narrow view angle due to a polarizing filter, a prism sheet and a diffuser, etc. Otherwise, the EL display device is largely classified into an inorganic EL device and an organic EL device depending on a material of a light-emitting layer,

and is a self-emitting device emitting for itself. The EL display device has great advantages of a rapid response speed and high emission efficiency, brightness and view angle. In the organic EL display device as shown in Fig. 1, an anode electrode 31 composed of a transparent electrode pattern is provided on a glass substrate 2, and a hole injecting layer 32, a light-emitting layer 33 and an electron injecting layer 34 are sequentially disposed thereon. A cathode electrode 35 composed of a metal electrode is provided on the electron injecting layer 34. If a driving voltage is applied to the anode electrode 31 and the cathode electrode 35, then holes within the hole injecting layer 32 and electrons within the electron injecting layer 34 go toward the light-emitting layer 33 to excite a fluorescent material within the light-emitting layer 33. A picture or an image is displayed by a visible light generated from the light-emitting layer 33 in this manner. Such an EL display device has a problem in that it is difficult to provide the EL device with a large-scale screen because the current mass-production technique and process does not yet keep up with a technical level capable of repetitively manufacturing a large screen of more than 10".

A study as to a method of patterning pixels of the EL device has been actively made by a set maker or a laboratory, but it is not yet possible to make a minute pattern and to make a repetitive manufacturing of red, green and blue pixels at a large-scale field. For instance, an organic EL material can not be patterned by the wet etching because it is liable to be melted by a solvent or moisture. For this reason, the organic EL material can not

be patterned by the photolithography advantageous for formation of minute patterns. A low-molecule organic EL material may be patterned using a method of independently forming each of red, green and blue materials after a minute-patterned shadow mask was installed on the substrate, but it has a limit in making an accurate minute-patterning enough to have a resolution of the shadow mask more than a certain level and it is difficult to be applied for a high-accuracy and large field due to a tension deviation, etc. of the shadow mask. A method of patterning pixels using an ink-jet injection head for a high-molecule or polymer organic EL material has been studied, but it has a difficulty in forming a pin-hole-free thin film of less than 1000Å . A scheme of providing color filters on a white EL material or providing a color changing medium on a blue EL material because it is impossible to form minute-pattern pixels in the EL display device as described above may be considered, but it brings about a large light loss caused by the color filters or the color changing medium.

[Technical subject matter to be solved by the invention]

Accordingly, it is an object of the present invention to provide an apparatus and method of patterning an electro-luminescent display device that is adaptive for forming pixels into minute patterns.

[Configuration and operation of the invention]

In order to achieve these and other objects of the invention, a apparatus of patterning an electro-luminescent display device according to the present invention includes: a molding plate provided with lands and grooves, each land

having a shape corresponding to a pixel pattern and being coated with a polymer solution, each groove being formed between the lands and not coated with the polymer solution; a polymer supplying roller for applying the polymer solution to the molding plate; and a molding roller, being attached to the molding plate, for printing the polymer solution coated on the molding plate on a substrate.

A method of patterning an electro-luminescent display device according to the present invention includes the steps of: 1) attaching a molding plate, on which convex and concave portions with a shape corresponding to a pixel pattern are formed, to a rotatable roller; 2) supplying a polymer solution to the molding plate; and 3) printing the polymer solution coated on the molding plate onto a substrate by a rotation of the roller.

Referring to Fig. 2, there is shown a patterning apparatus for an electro-luminescent display device according to an embodiment of the present invention. The patterning apparatus includes a molding plate 6 provided with lands 12 and grooves 14, a molding roller 4 to which the molding plate 6 is attached, and a polymer supply roller 8 for applying an EL polymer solution onto the lands 12 of the molding plate 6. Under the molding roller 4, a glass substrate 2 to be printed is supplied. The lands 12 are protruded in a stripe shape between the grooves 14 as shown in Fig. 4. On a surface of each land 12 is formed a number of hemispherical grooves 12a, shown in Fig. 5. The lands 12 contacts the polymer supply roller 8 coated with the EL polymer solution to be uniformly coated with the EL polymer solution into a desired thickness (i.e., less than 1000Å).

While, the grooves 14 of the molding plate 6 are not coated with the EL polymer solution because they do not contact the polymer supply roller 8. The molding roller 4 plays a role to coat the EL polymer solution coated on the surface of the polymer supply roller 8 on the lands 12 of the molding plate 6 by its rotating motion. Also, the molding roller 4 contact the lands 12 of the molding plate 6 coated with the EL polymer solution with the glass substrate 2 by its rotating motion. The polymer supply roller 8 contacts the molding plate 6 attached to the molding roller 4 and is rotatably installed to apply an EL polymer solution supplied to itself to the lands 12 of the molding plate 6. A blade or other roller can be installed adjacently to the surface of the polymer supply roller 8 so that the polymer solution applied to the lands 12 of the molding plate 6 may be evenly coated into a uniform thickness.

A process of patterning light-emitting layer of the EL display device using the patterning apparatus as mentioned above will be described below. First, an EL polymer solution 16 with any one color of red, green and blue is applied to the polymer supply roller 8. Then, the EL polymer solution 16 is coated on the polymer supply roller 8 to be coated on the lands 12 of the molding plate 6 by means of the polymer supply roller 8 moving rotationally. At this time, the molding roller 4 is linked to the rotating polymer supply roller 8 to be rotated in a direction contrary to the polymer supply roller 8. The EL polymer solution coated on the lands 12 of the molding plate 6 as shown in Fig. 3 contacts the glass substrate 2 supplied under the molding roller 4 by a rotating motion of the molding roller 4. At this time, the EL polymer solution

16 coated on the lands 12 of the molding plate 6 is inversely propagated into the glass substrate 2 as shown in Fig. 6A. The lands 12 printed with the polymer solution 16 on the glass substrate 2 are separated from the glass substrate 2 as shown in Fig. 6B by a rotation of the molding roller 4. The EL polymer solution 16 printed on the glass substrate 2 is changed to have an even surface as shown in Fig. 6C just after the printing. Subsequently, the EL polymer solution 16 on the glass substrate 2 is fired at a desired temperature. As a result, the pixel pattern 18 is provided at the glass substrate 2. After the pixel pattern 18 with a specific color was formed as described above, the pixel pattern with other color is provided in the similar manner.

The patterning method of printing the pixel patterns on the glass substrate 2 using the roller as described above is applicable to the formation of the red, green and blue minute patterns on the light-emitting layer like the above embodiment, but may be used to form other organic material layer included in the EL, for example, a hole injecting layer or an electron injecting layer. Such a method can reduce a waste of material in comparison to the conventional spin-coating method.

However, the method of forming the EL organic material layer on the substrate using the roller accelerates a membrane spread of the pixel pattern or the organic material layer 20a as shown in Figs. 7A to 7C just after the printing as a wetting characteristic and a leveling characteristic of the EL polymer solution go larger. As a result, the pixel pattern or the organic material layer 20a

formed on the substrate has not only a non-uniform thickness, but also the color purity and device characteristic are deteriorated. In order to reduce a membrane spread of the pixel pattern or the organic material layer 20a, the patterning method according to the second embodiment of the present invention provides barrier ribs 50 for reducing a membrane spread of the organic material between the adjacent pixel pattern areas as shown in Fig. 8.

Referring now to Fig. 9A, the barrier ribs 50 are provided at a desired space on the glass substrate 2 in the patterning method according to the second embodiment. Between the barrier ribs 50, an indium-tin-oxide (ITO) pattern 52 used as a pixel electrode is provided. The barrier rib 50 is formed into a larger thickness than a pixel pattern or an organic material layer 18 to be formed on the glass substrate 2. A material of the barrier rib 50 can be selected from any one of organic materials such as SiN_X and SiO_2, etc. and inorganic materials such as a polyimide and an acryl group, etc. Subsequently, the EL polymer solution 16 is printed on the ITO pattern 52 using the molding roller 4 and the molding plate 6 as mentioned above. At this time, a membrane spread of the EL polymer solution 16 is limited by the barrier rib 50, so that the EL polymer solution 16 is formed into a uniform thickness on the glass substrate 2. After the red pixel pattern 18 was formed in this manner, the green pixel pattern and the blue pixel pattern are sequentially formed in the similar manner.

Fig. 10 and Figs. 11A to 11D show a patterning method

according to a third embodiment of the present invention, which is applied to an EL device provided with TFT's as switching devices.

Referring to Fig. 10, barrier ribs 40 are provided on the glass substrate 2 to cover the edges of ITO patterns 42. The barrier rib 40 covers the edge of the ITO pattern 42, a source line 44, a gate line 48 and a TFT 48. Also, the barrier rib 40 is formed into a larger thickness than the pixel pattern or the organic material layer 18 printed on the ITO pattern 42. A material of the barrier rib 40 can be selected from any one of organic materials such as SiN_X and SiO_2, etc. and inorganic materials such as a polyimide and an acryl group, etc.

Referring now to Figs. 11A, the barrier rib 40 has a neck 40b with a small width and a head 40a with a large width. The edge of the ITO pattern 42 is inserted into the neck 40b. Thus, the edge of the ITO pattern 42 is covered with the head 40a of the barrier rib 40. Subsequently, the EL polymer solution 16 is printed on the ITO pattern 42 as shown in Figs. 11B and 11C using the molding roller 4 and the molding plate 6 as mentioned above. At this time, a membrane spread of the EL polymer solution 16 is limited by the head 40a of the barrier rib 40, so that the EL polymer solution 16 is formed into a uniform thickness on the glass substrate 2. After the red pixel pattern 18 was formed in this manner, the green pixel pattern and the blue pixel pattern are sequentially formed in the similar manner.

[Effect of the invention]

As described above, according to the present invention,

after the molding plate molded into a pixel pattern shape was attached to coat the molding plate with the EL polymer solution, which then is inversely propagated onto the glass substrate, thereby forming the pixels into minute patterns. Furthermore, the barrier ribs are provided between the pixel patterns to prevent the membrane spread generated at the time of printing the EL polymer solution as well as to minimize a deterioration of the devices beginning with the edged of the ITO patterns with the aid of the barrier ribs, so that a reliability can be raised and a life can be prolonged.

Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.

[What is claimed is]

1. A apparatus of patterning an electro-luminescent display, comprising:

a molding plate provided with lands and grooves, each land having a shape corresponding to a pixel pattern and being coated with a polymer solution, each groove being formed between the lands and not coated with the polymer solution;

a polymer supplying roller for applying the polymer solution to the molding plate; and

a molding roller, being attached to the molding plate, for printing the polymer solution coated on the molding plate on a substrate.

2. The patterning apparatus according to claim 1, wherein minute patterns are formed on a surface of the each land of the molding plate.

3. The patterning apparatus according to claim 1, wherein the polymer solution includes a polymer excited and emitted by a carrier.

4. A method of patterning an electro-luminescent display, comprising the steps of:

1) attaching a molding plate, on which convex and concave portions with a shape corresponding to a pixel pattern are formed, to a rotatable roller;

2) supplying a polymer solution to the molding plate; and

3) printing the polymer solution coated on the molding plate onto a substrate by a rotation of the roller.

5. The method according to claim 4, wherein the steps 1) to 3) are repeated to form red, green and blue pixel patterns on the substrate.

6. The method according to claim 4, further comprising the step of:

forming barrier ribs for preventing a membrane spread of the polymer solution on the substrate before the polymer solution is printed on the substrate.

7. The method according to claim 6, wherein each of the barrier ribs is formed at a boundary between pixels.

8. The method according to claim 6, wherein an upper portion of each of the barrier ribs covers the edge of the pixel pattern.